5.4.1 SEVERE STORM

This section provides a profile and vulnerability assessment for the severe storm hazard.

HAZARD PROFILE

This section provides profile information including description, extent, location, previous occurrences and losses and the probability of future occurrences.

Description

For the purpose of this HMP and as deemed appropriated by the County, the severe storm hazard includes hailstorms, windstorms, lightning, thunderstorms, tornadoes, and tropical cyclones (e.g. hurricanes, tropical storms, and tropical depressions), which are defined below. Since most northeasters, (or Nor'Easters) a type of an extra-tropical cyclone, generally take place during the winter weather months, Nor'Easters have been grouped as a type of severe winter weather storm, further discussed in Section 5.4.2 Severe Winter Storm.

Hailstorm: According to the National Weather Service (NWS), hail is defined as a showery precipitation in the form of irregular pellets or balls of ice more than five millimeters in diameter, falling from a cumulonimbus cloud (NWS, 2005). Early in the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until, having developed sufficient weight; they fall as precipitation, in the form of balls or irregularly shaped masses of ice. The size of hailstones is a direct function of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface. Higher temperature gradients relative to elevation above the surface result in increased suspension time and hailstone size. Hailstorms are a potential damaging outgrowth of severe thunderstorms (Northern Virginia Regional Commission [NVRC], 2006). They cause over $1 billion in crop and property damages each year in the U.S., making hailstorms one of the most costly natural disasters (Federal Alliance for Safe Homes, Inc., 2006).

Windstorm: According to the Federal Emergency Management Agency (FEMA), wind is air moving from high to low pressure. It is rough horizontal movement of air (as opposed to an air current) caused by uneven heating of the Earth's surface. It occurs at all scales, from local breezes generated by heating of land surfaces and lasting tens of minutes to global winds resulting from solar heating of the Earth (FEMA, 1997). A type of windstorm that is experienced often during rapidly moving thunderstorms is a derecho. A derecho is a widespread and long-lived windstorm associated with thunderstorms that are often curved in shape (Johns and Evans, Data Unknown). The two major influences on the atmospheric circulation are the differential heating between the equator and the poles, and the rotation of the planet. Windstorm events are associated with cyclonic storms (for example, hurricanes), thunderstorms and tornadoes (FEMA, 1997).

Lightning: According to the NWS, lightning is a visible electrical discharge produced by a thunderstorm. The discharge may occur within or between clouds or between a rain cloud and the ground (NWS, 2005). The discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm creates a "bolt" when the buildup of charges becomes strong enough. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit (°F). Lightning rapidly heats the sky as it flashes but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder. Annually, on average, 300 people are injured and 89 people are killed due to lightning strikes in the U.S. (NVRC, 2006).

Thunderstorm: According to the NWS, a thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (NWS, 2005). A thunderstorm forms from a combination of moisture, rapidly rising warm air and a force capable of lifting air such as a warm and cold front, a sea breeze, or a mountain. Thunderstorms form from the equator to as far north as Alaska. These storms occur most commonly in the tropics. Many tropical land-based locations experience over 100 thunderstorm days each year (Pidwirny, 2007). Although thunderstorms generally affect a small area when they occur, they are very dangerous because of their ability to generate tornadoes, hailstorms, strong winds, flash flooding, and damaging lightning. A thunderstorm produces wind gusts less than 57 miles per hour (mph) and hail, if any, of less than 3/4-inch diameter at the surface. A severe thunderstorm has thunderstorm related surface winds (sustained or gusts) of 57 mph or greater and/or surface hail 3/4-inch or larger (NWS, 2005). Wind or hail damage may be used to infer the occurrence/existence of a severe thunderstorm (Office of the Federal Coordinator for Meteorology, 2001).

Tornado: A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. It is spawned by a thunderstorm (or sometimes as a result of a hurricane) and produced when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. Tornado season is generally March through August, although tornadoes can occur at any time of year (FEMA, 2004). Tornadoes tend to strike in the afternoons and evening, with over 80 percent (%) of all tornadoes striking between noon and midnight (New Jersey Office of Emergency Management [NJOEM], 2005). The average forward speed of a tornado is 30 mph, but can vary from nearly stationary to 70 mph (NWS, 1995). The NOAA Storm Prediction Center (SPC) indicates that the total duration of a tornado can last between a few seconds to over one hour; however, a tornado typical lasts less than 10 minutes (Edwards, 2009). High-wind velocity and wind-blown debris, along with lightning or hail, result in the damage caused by tornadoes. Destruction caused by tornadoes depends on the size, intensity, and duration of the storm. Tornadoes cause the greatest damage to structures that are light, such as residential homes and mobile homes, and tend to remain localized during impact (NVRC, 2006).

Tropical Cyclone: Tropical cyclone is a generic term for a cyclonic, low-pressure system over tropical or sub-tropical waters (National Atlas, 2009); containing a warm core of low barometric pressure which typically produces heavy rainfall, powerful winds and storm surge (New York City Office of Emergency Management [NYCOEM], 2007). It feeds on the heat released when moist air rises and the water vapor in it condenses (Dorrego, Date Unknown). Depending on their location and strength, there are various terms by which tropical cyclones are known, such as hurricane, typhoon, tropical storm, cyclonic storm and tropical depression (Pacific Disaster Center, 2006). While tropical cyclones begin as a tropical depression, meaning the storm has sustained winds below 38 mph, it may develop into a tropical storm (with sustained winds of 39 to 73 mph) or a hurricane (with winds of 74 mph and higher).

Tropical Depression: A tropical depression is an organized system of clouds and thunderstorms with a defined surface circulation and maximum sustained winds of less than 38 mph. It has no “eye” (the calm area in the center of the storm) and does not typically have the organization or the spiral shape of more powerful storms (Emanuel, Date Unknown; Miami Museum of Science, 2000).

Tropical Storm: A tropical storm is an organized system of strong thunderstorms with a defined surface circulation and maximum sustained winds between 39 and 73 mph (FEMA, 2007). Once a storm has reached tropical storm status, it is assigned a name. During this time, the storm itself becomes more organized and begins to become more circular in shape, resembling a hurricane. The rotation of a tropical storm is more recognizable than a tropical depression. Tropical storms can cause a lot of problems, even without becoming a hurricane; however, most of the problems stem from heavy rainfall (University of Illinois, Date Unknown).

Hurricane: A hurricane is an intense tropical cyclone with wind speeds reaching a constant speed of 74 mph or more (FEMA, 2004). It is a category of tropical cyclone characterized by thunderstorms and defined surface wind circulation. They are caused by the atmospheric instability created by the collision of warm air with cooler air. They form in the warm waters of tropical and sub-tropical oceans, seas, or Gulf of Mexico (NWS, 2000). Most hurricanes evolve from tropical disturbances. A tropical disturbance is a discrete system of organized convection (showers or thunderstorms), that originate in the tropics or subtropics, does not migrate along a frontal boundary, and maintains its identity for 24 hours or more (NWS, 2004). Hurricanes begin when areas of low atmospheric pressure move off the western coast of Africa and into the Atlantic, where they grow and intensify in the moisture-laden air above the warm tropical ocean. Air moves toward these atmospheric lows from all directions and circulates clock-wise under the influence of the Coriolis effect, thereby initiating rotation in the converging wind fields. When these hot, moist air masses meet, they rise up into the atmosphere above the low pressure area, potentially establishing a self-reinforcing feedback system that produces weather systems known to meteorologists as tropical disturbances, tropical depressions, tropical storms, and hurricanes (Frankenberg, 1999).

Almost all tropical storms and hurricanes in the Atlantic basin, which includes the Gulf of Mexico and Caribbean Sea, form between June 1st and November 30th. This time frame is known as hurricane season. August and September are peak months for hurricane development. The threats caused by an approaching hurricane can be divided into three main categories: storm surge, wind damage and rainfall/flooding:

- *Storm Surge* is simply water that is pushed toward the shore by the force of the winds swirling around the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the mean water level 15 feet or more. Storm surge is responsible for nearly 90-percent of all hurricane-related deaths and injuries.
- *Wind Damage* is the force of wind that can quickly decimate the tree population, down power lines and utility poles, knock over signs, and damage/destroy homes and buildings. Flying debris can also cause damage to both structures and the general population. When hurricanes first make landfall, it is common for tornadoes to form which can cause severe localized wind damage.
- *Rainfall / Flooding* the torrential rains that normally accompany a hurricane can cause serious flooding. Whereas the storm surge and high winds are concentrated around the "eye", the rain may extend for hundreds of miles and may last for several days, affecting areas well after the hurricane has diminished (Mandia, 2007).

Extent

The extent (that is, magnitude or severity) of a severe storm is largely dependent upon sustained wind speed. Straight-line winds, winds that come out of a thunderstorm, in extreme cases, can cause wind gusts exceeding 100 mph. These winds are most responsible for hailstorm and thunderstorm wind damage. One type of straight-line wind, the downburst, can cause damage equivalent to a strong tornado (NVRC, 2006).

Tornado

The magnitude or severity of a tornado was originally categorized using the Fujita Scale (F-Scale) or Pearson Fujita Scale introduced in 1971, based on a relationship between the Beaufort Wind Scales (B-Scales) (measure of wind intensity) and the Mach number scale (measure of relative speed). It is used to rate the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man-made structure (Tornado Project, Date Unknown). The F-Scale categorizes each tornado by intensity and area. The scale is divided into six categories, F0 (Gale) to F5 (Incredible) (SPC, 2009). Table 5.4.1-1 explains each of the six F-Scale categories.

Table 5.4.1-1. Fujita Damage Scale

Scale	Wind Estimate (MPH)	Typical Damage
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur.

Source: SPC, Date Unknown

Although the F-Scale has been in use for over 30 years, there are limitations of the scale. The primary limitations are a lack of damage indicators, no account of construction quality and variability, and no definitive correlation between damage and wind speed. These limitations have led to the inconsistent rating of tornadoes and, in some cases, an overestimate of tornado wind speeds. The limitations listed above led to the development of the Enhanced Fujita Scale (EF Scale). The Texas Tech University Wind Science and Engineering (WISE) Center, along with a forum of nationally renowned meteorologists and wind engineers from across the country, developed the EF Scale (NWS, 2007).

The EF Scale became operational on February 1, 2007. It is used to assign tornadoes a 'rating' based on estimated wind speeds and related damage. When tornado-related damage is surveyed, it is compared to a list of Damage Indicators (DIs) and Degrees of Damage (DOD), which help better estimate the range of wind speeds produced by the tornado. From that, a rating is assigned, similar to that of the F-Scale, with six categories from EF0 to EF5, representing increasing degrees of damage. The EF Scale was revised from the original F-Scale to reflect better examinations of tornado damage surveys. This new scale has to do with how most structures are designed (NWS, 2007). Table 5.4.1-2 displays the EF Scale and each of its six categories.

Table 5.4.1-2. Enhanced Fujita Damage Scale

F-Scale Number	Intensity Phrase	Wind Speed (mph)	Type of Damage Done
EF0	Light tornado	65–85	Light damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	Moderate tornado	86-110	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	Significant tornado	111-135	Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	Severe tornado	136-165	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	Devastating tornado	166-200	Devastating damage. Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	Incredible tornado	>200	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Source: SPC, 2009

In the Fujita Scale, there was a lack of clearly defined and easily identifiable damage indicators. The EF Scale takes into account more variables than the original F-Scale did when assigning a wind speed rating to a tornado. The EF Scale incorporates 28 damage indicators (DIs), such as building type, structures, and trees. For each damage indicator, there are eight degrees of damage (DOD), ranging from the beginning of visible damage to complete destruction of the damage indicator. Table 5.4.1-3 lists the 28 DIs. Each one of these indicators has a description of the typical construction for that category of indicator. Each DOD in every category is given an expected estimate of wind speed, a lower bound of wind speed, and an upper bound of wind speed.

Table 5.4.1-3. Enhanced F-Scale Damage Indicators

Number	Damage Indicator	Abbreviation	Number	Damage Indicator	Abbreviation
1	Small barns, farm outbuildings	SBO	15	School - 1-story elementary (interior or exterior halls)	ES
2	One- or two-family residences	FR12	16	School - jr. or sr. high school	JHSH
3	Single-wide mobile home (MHSW)	MHSW	17	Low-rise (1-4 story) bldg.	LRB

Number	Damage Indicator	Abbreviation	Number	Damage Indicator	Abbreviation
4	Double-wide mobile home	MHDW	18	Mid-rise (5-20 story) bldg.	MRB
5	Apt, condo, townhouse (3 stories or less)	ACT	19	High-rise (over 20 stories)	HRB
6	Motel	M	20	Institutional bldg. (hospital, govt. or university)	IB
7	Masonry apt. or motel	MAM	21	Metal building system	MBS
8	Small retail bldg. (fast food)	SRB	22	Service station canopy	SSC
9	Small professional (doctor office, branch bank)	SPB	23	Warehouse (tilt-up walls or heavy timber)	WHB
10	Strip mall	SM	24	Transmission line tower	TLT
11	Large shopping mall	LSM	25	Free-standing tower	FST
12	Large, isolated ("big box") retail bldg.	LIRB	26	Free standing pole (light, flag, luminary)	FSP
13	Automobile showroom	ASR	27	Tree - hardwood	TH
14	Automotive service building	ASB	28	Tree - softwood	TS

Source: SPC, Date Unknown

Since the EF Scale recently went into effect in February 2007, previous occurrences and losses associated with historic tornado events, described in the next section (Previous Occurrences and Losses) of this hazard profile are based on the former Fujita Scale.

Hurricanes

The extent of a hurricane is categorized by the Saffir-Simpson Hurricane Scale. This scale categorizes or rates hurricanes from 1 (Minimal) to 5 (Catastrophic) based on their intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf and the shape of the coastline, in the landfall region (National Hurricane Center [NHC], 2007). Table 5.4.1-4 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes land fall.

Table 5.4.1-4. The Saffir-Simpson Scale

Category	Wind Speed (mph)	Storm Surge (above normal sea level)	Expected Damage
1	74-95	4 – 5 feet	Minimal: Damage is done primarily to shrubbery and trees, unanchored mobile homes are damaged, some signs are damaged, and no real damage is done to structures.

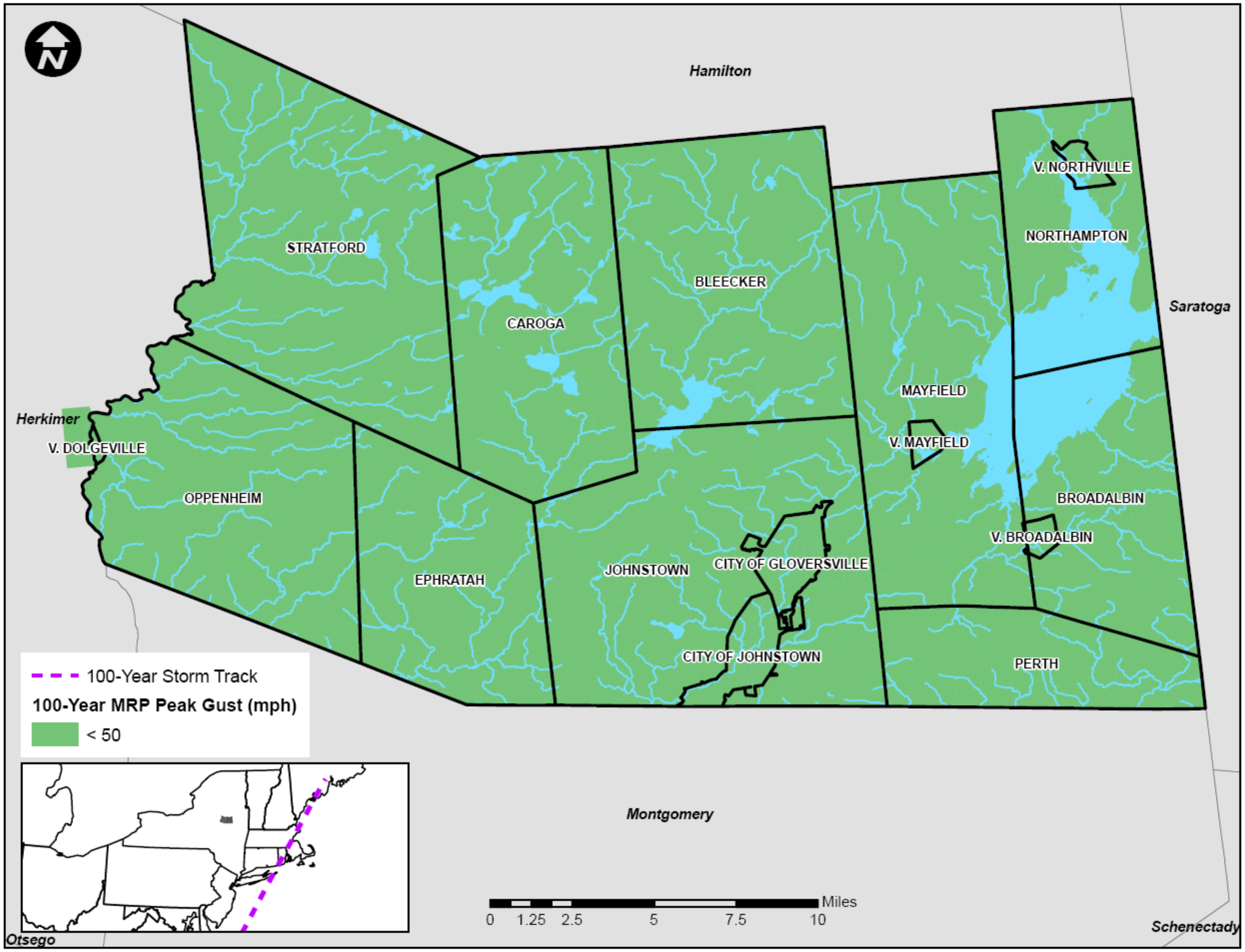
Category	Wind Speed (mph)	Storm Surge (above normal sea level)	Expected Damage
2	96-110	6 – 8 feet	Moderate: Some trees are toppled, some roof coverings are damaged, and major damage is done to mobile homes.
3	111-130	9 – 12 feet	Extensive: Large trees are toppled, some structural damage is done to roofs, mobile homes are destroyed, and structural damage is done to small homes and utility buildings.
4	131-155	13 – 18 feet	Extreme: Extensive damage is done to roofs, windows, and doors; roof systems on small buildings completely fail; and some curtain walls fail.
5	> 155	> 18 feet	Catastrophic: Roof damage is considerable and widespread, window and door damage is severe, there are extensive glass failures, and entire buildings could fail.
Additional Classifications			
Tropical Storm	39-73	0 - 3 feet	NA
Tropical Depression	< 38	0	NA

Source: FEMA, 2007
mph = Miles per hour
> = Greater than
NA = Not applicable or not available

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. MRP is the average period of time, in years, between occurrences of a particular hazard event (equal to the inverse of the annual frequency of exceedance) (Dinicola, 2009).

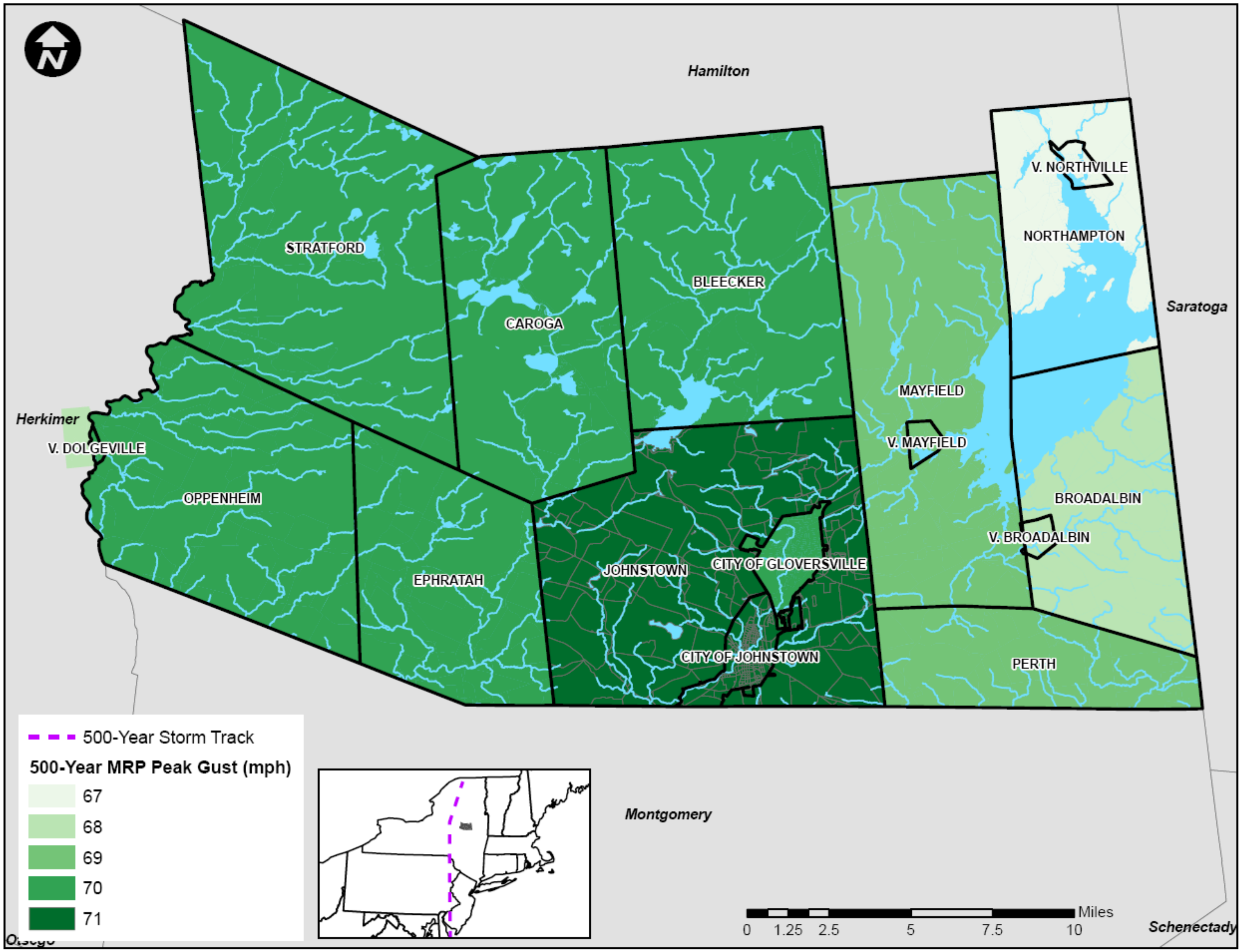
Figure 5.4.1-1 and 5.4.1-2 show the estimated maximum 3-second gust wind speeds that can be anticipated in the study area associated with the 100- and 500-year MRP HAZUS-MH model runs. The estimated hurricane track for the 100- and 500-year event is also shown. The maximum 3-second gust wind speeds for the County are less than 50-mph for the 100-year MRP event; wind speeds characteristic of a tropical storm. The maximum 3-second gust wind speeds for the County range from 67 to 71 mph for the 500-year MRP event; wind speeds characteristic of a tropical storm and nearly a Category 1 hurricane. The associated impacts and losses from these 100-year and 500-year MRP hurricane event model runs are reported in the Vulnerability Assessment later in this section.

Figure 5.4.1-1. Peak Wind Speeds for the 100-Year MRP Wind Event in Fulton County



Source: HAZUS-MH MR4, 2009

Figure 5.4.1-2. Peak Wind Speeds for the 500-Year MRP Wind Event in Fulton County



Source: HAZUS-MH MR4, 2009

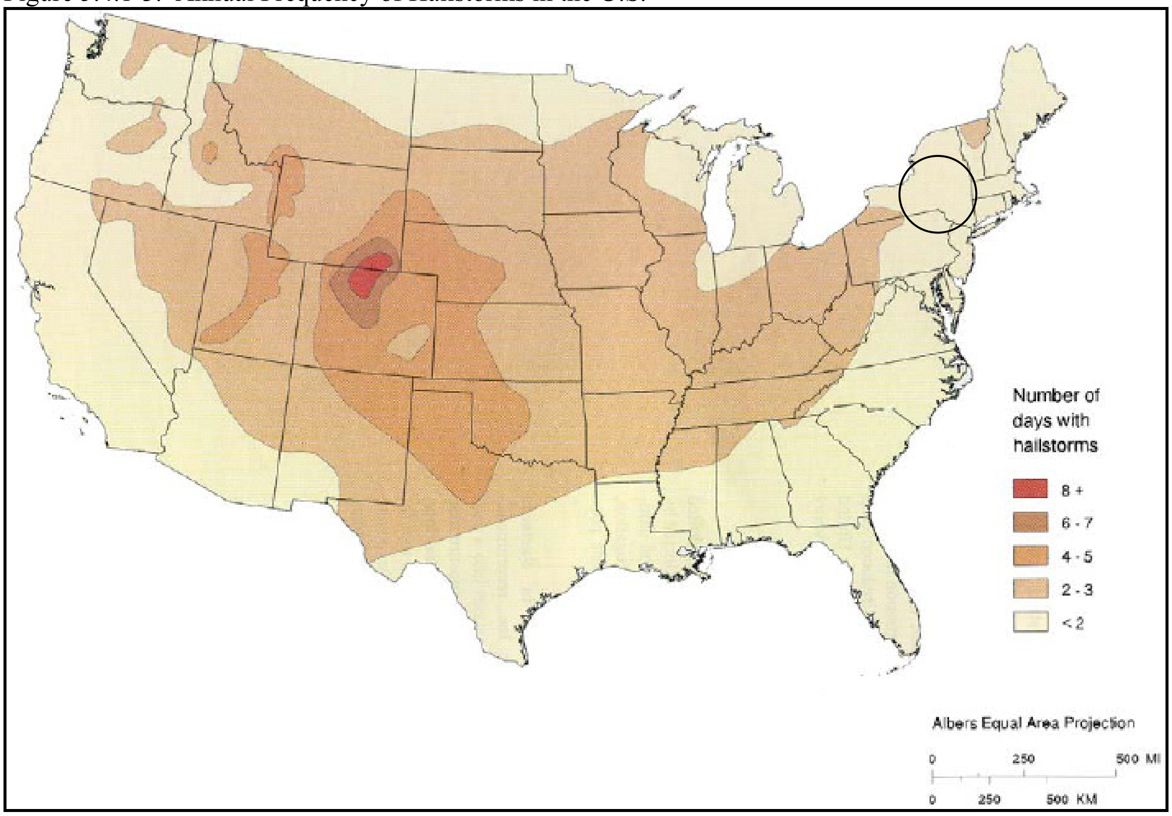
Location

Severe storms are a common natural hazard in New York State because the State exhibits a unique blend of weather (geographically and meteorological) features that influence the potential for severe storms and associated flooding. Factors include temperature, which is affected by latitude, elevation, proximity to water bodies and source of air masses; and precipitation which includes snowfall and rainfall. Precipitation intensities and effects are influenced by temperature, proximity to water bodies, and general frequency of storm systems. The Cornell Climate Report also indicates that the geographic position of the State (Northeast U.S.) makes it vulnerable to frequent storm and precipitation events. This is because nearly all storms and frontal systems moving eastward across the continent pass through, or in close proximity to New York State. Additionally, the potential for prolonged thunderstorms or coastal storms and periods of heavy precipitation is increased throughout the state because of the available moisture that originates from the Atlantic Ocean (NYSDPC, 2008).

Hailstorms

Hailstorms are more frequent in the southern and central plain states, where the climate produces violent thunderstorms. However, hailstorms have been observed in almost every location where thunderstorms occur (Federal Alliance for Safe Homes, Inc, 2006). Figure 5.4.1-3 illustrates that Fulton County and most of New York State experience less than two hailstorms per year.

Figure 5.4.1-3. Annual Frequency of Hailstorms in the U.S.



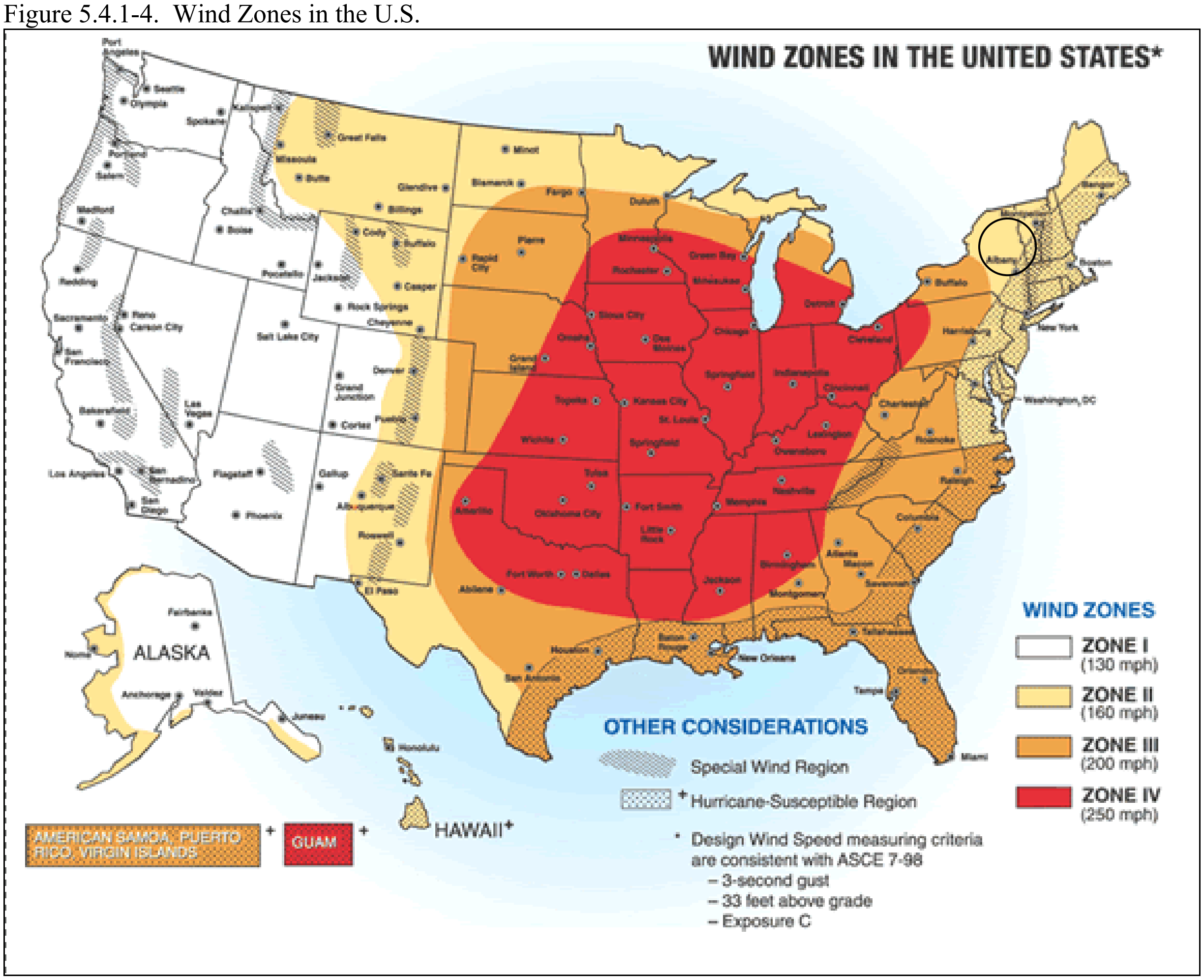
Source: NVRC, 2006
Note: The black circle indicates the approximate location of Fulton County. Fulton County experiences less than two hailstorms a year.

Windstorms

Figure 5.4.1-4 indicates how the frequency and strength of windstorms impacts the U.S. and the general location of the most wind activity. This is based on 40 years of tornado history and 100 years of hurricane history, collected by FEMA. States located in Wind Zone IV have experienced the greatest number of tornadoes and the strongest tornadoes (NVRC, 2006). Fulton County is located in Wind Zone II with speeds up to 160 miles per hour (FEMA, 2006).

The New York State Hazard Mitigation Plan (NYS HMP) identifies counties most vulnerable to wind, as determined by a rating score. Counties accumulate points based on the value of each vulnerability indicator, the higher then indication for wind exposure the more points assigned, resulting in a final rating score. Fulton County was given a rating score of 8, a medium vulnerability to wind exposure (NYSDPC, 2008).

Figure 5.4.1-4. Wind Zones in the U.S.

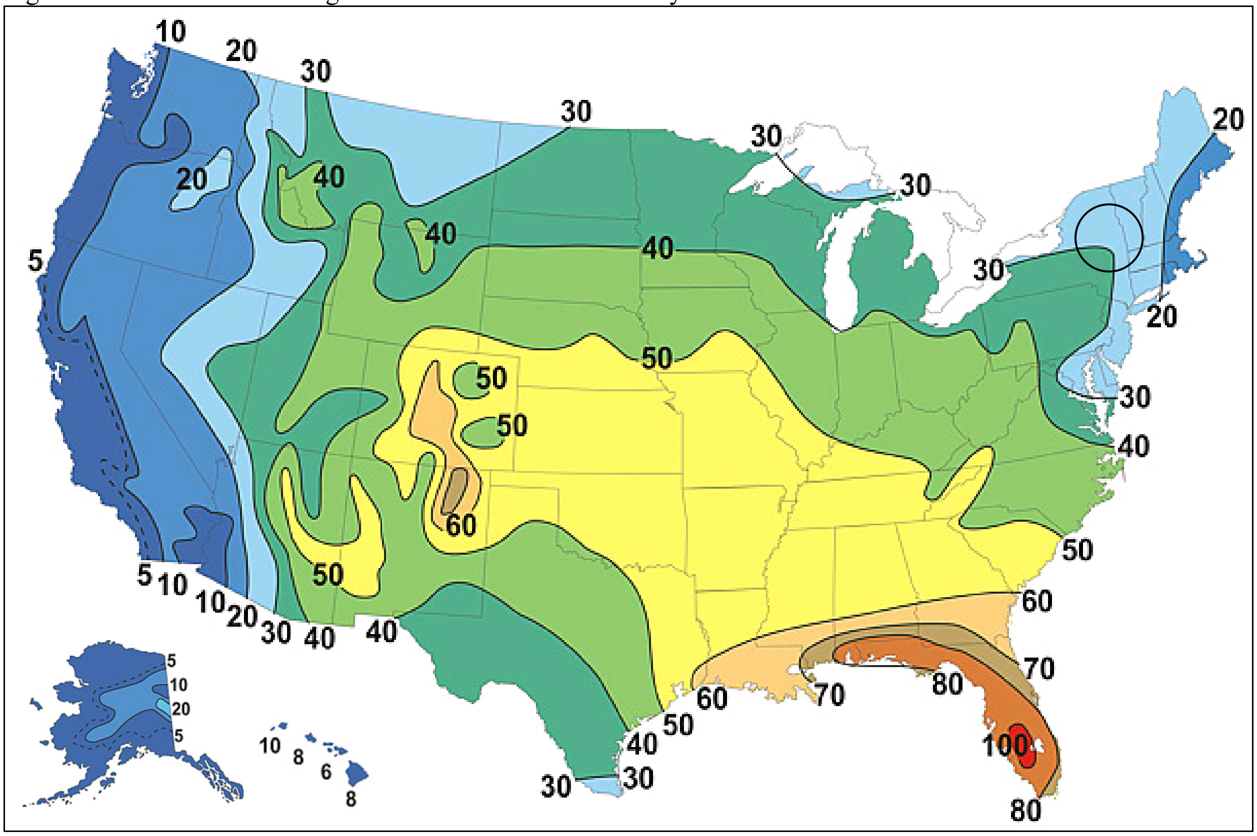


Source: FEMA, 2006
Note: The black circle indicates the approximate location of Fulton County.

Thunderstorms

Thunderstorms affect relatively small localized areas, rather then large regions much like winter storms, and hurricane events (NWS, 2005). Thunderstorms can strike in all regions of the U.S.; however, they are most common in the central and southern states. The atmospheric conditions in these regions of the country are most ideal for generating these powerful storms (NVRC, 2006). It is estimated that there are as many as 40,000 thunderstorms each day world-wide. Figure 5.4.1-5 shows the average number of thunderstorm days throughout the U.S. The most thunderstorms are seen in the southeast states, with Florida having the highest incidences (80 to over 100 thunderstorm days each year) (NWS, 2010). This figure indicates that Fulton County experiences between 20 and 30 thunderstorm days each year.

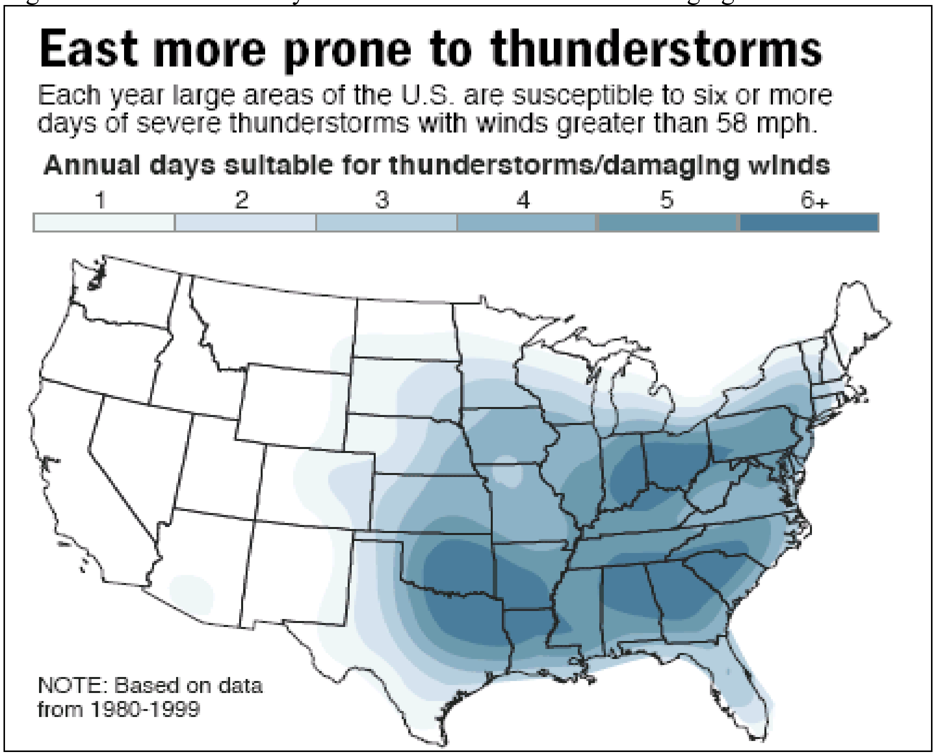
Figure 5.4.1-5. Annual Average Number of Thunderstorm Days in the U.S.



Source: NWS, 2010
Note: The black circle indicates the approximate location of Fulton County.

NASA scientists suggest that the U.S. will face more severe thunderstorms in the future, with deadly lightning, damaging hail and the potential for tornadoes in the event of climate change (Borenstein, 2007). A recent study conducted by NASA predicts that smaller storm events like thunderstorms will be more dangerous due to climate change (Figure 5.4.1-6). As prepared by the NWS, Figure 5.4.1-6 identifies those areas, particularly within the eastern U.S. that are more prone to thunderstorms, which includes New York State.

Figure 5.4.1-6. Annual Days Suitable for Thunderstorms/Damaging Winds

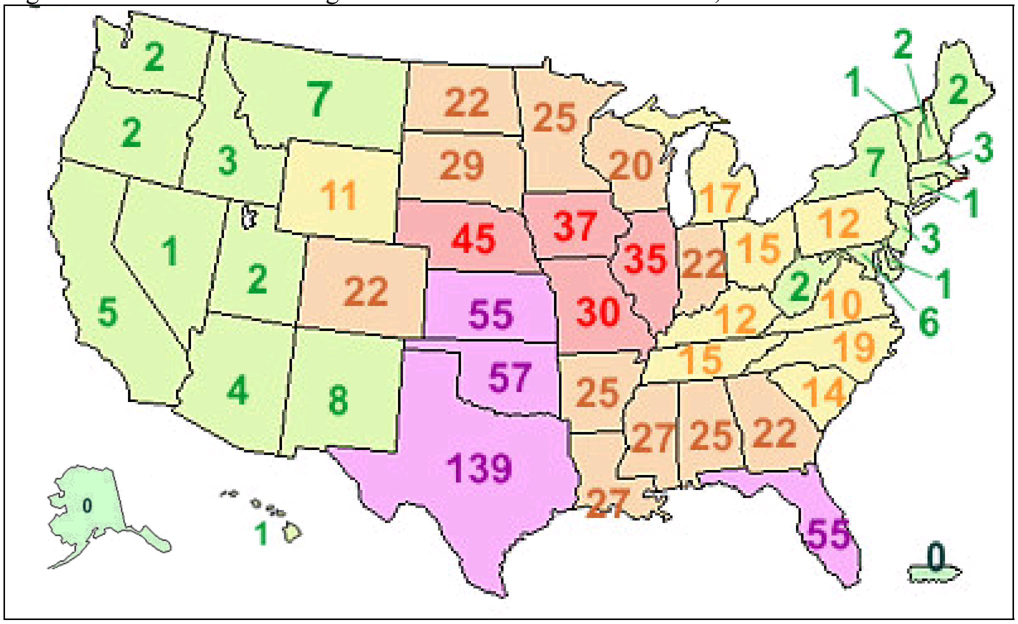


Source: MSNBC.com, 2007

Tornado

The U.S. experiences more tornadoes than any other country. In a typical year, approximately 1,000 tornadoes affect the U.S. The peak of the tornado season is April through June, with the highest concentration of tornadoes in the central U.S. Figure 5.4.1-7 shows the annual average number of tornadoes between 1953 and 2004 (NWS, 2010). New York State experienced an average of seven tornado events annually between 1953 and 2004.

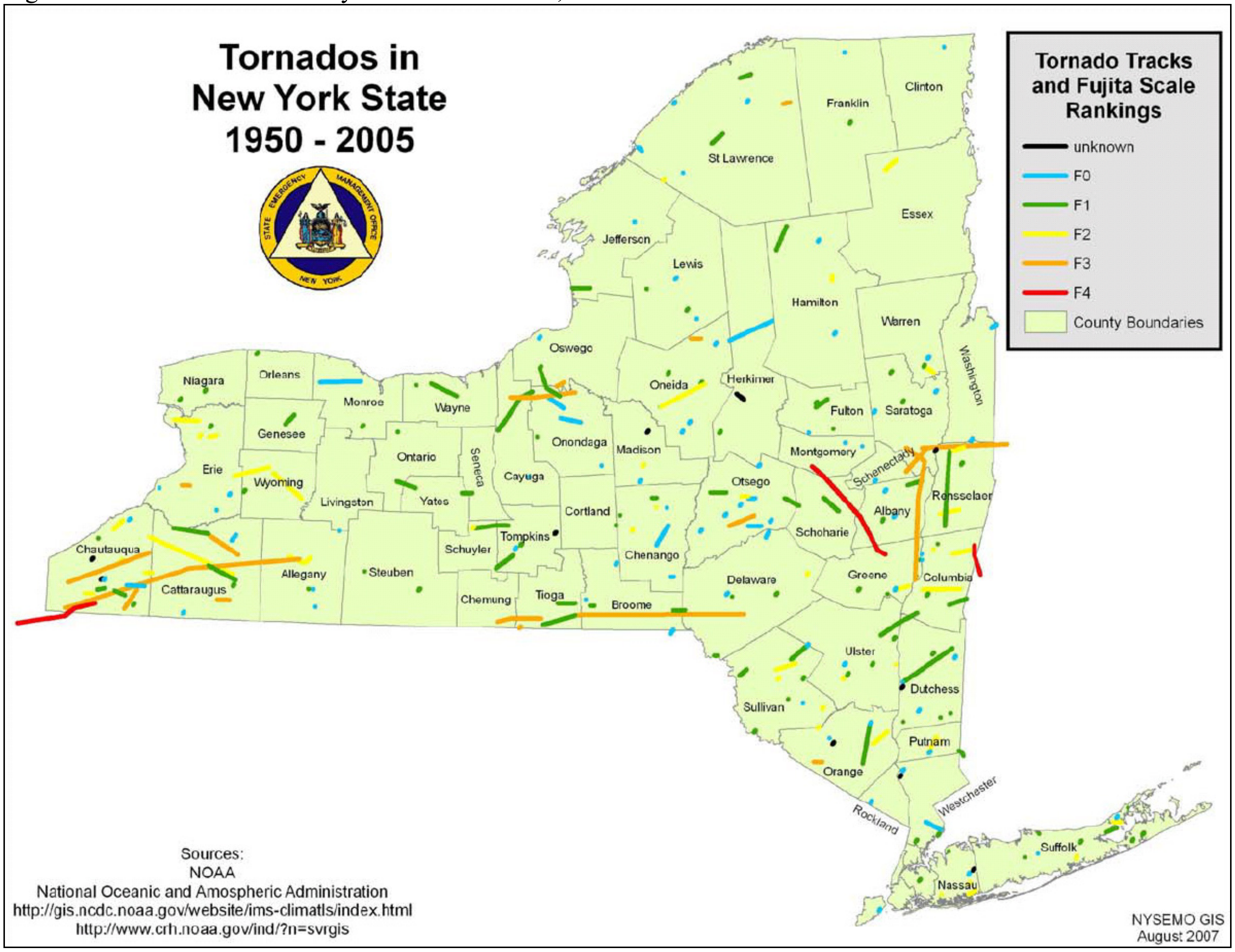
Figure 5.4.1-7. Annual Average Number of Tornadoes in the U.S., 1953 to 2004



Source: NWS, 2010
Note: Between 1953 and 2004, New York State experienced an average of seven tornadoes each year.

New York State ranks 30th in the U.S. for frequency of tornadoes. When compared to other states on the frequency of tornadoes per square mile, the State ranks 35th (The Disaster Center, 2007). New York State has a definite vulnerability to tornadoes and can occur, based on historical occurrences, in any part of the State. According to Figure 5.4.1-8, every county in New York State has experienced a tornado between 1950 and 2005 (NYSDPC, 2008).

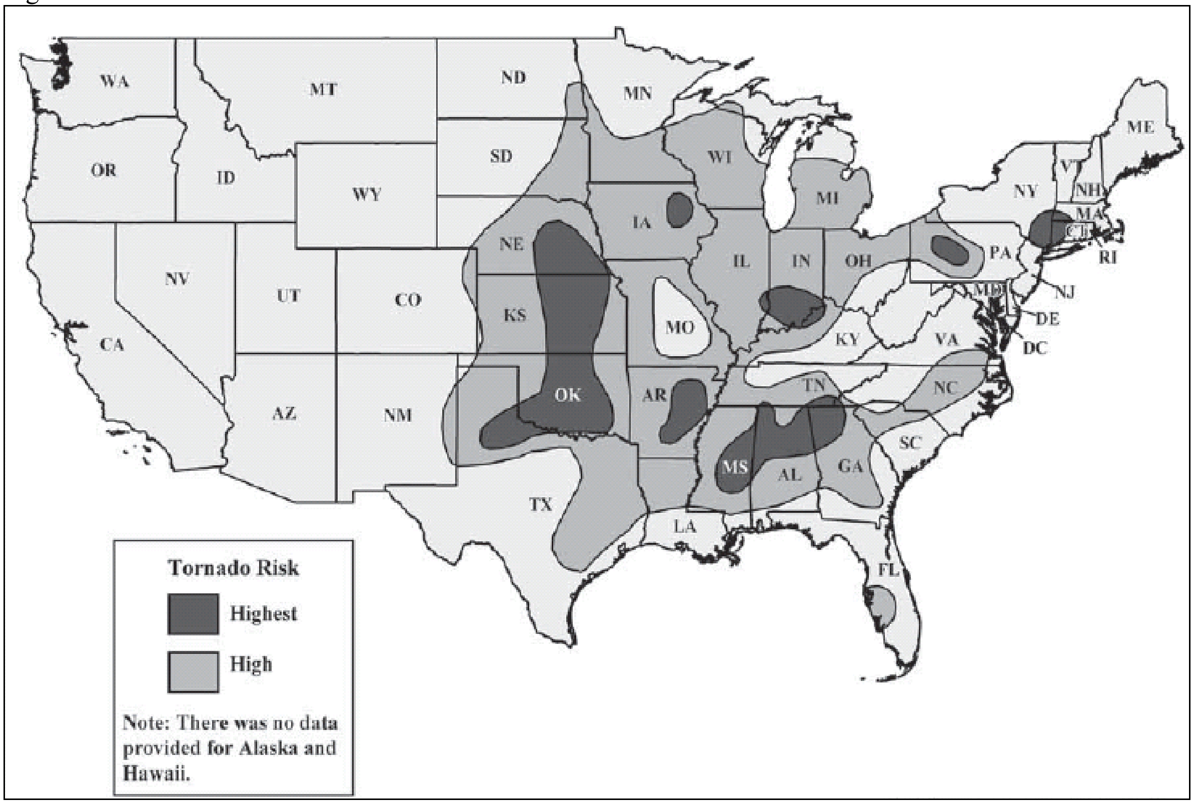
Figure 5.4.1-8. Tornado Activity in New York State, 1950-2005



Source: NYSDPC, 2008

Figure 5.4.1-9 indicates that a majority of the State, with the exception of the southeastern section (Mid-Hudson Region), has an overall low risk of tornado activity, which includes portions of Fulton County. Details regarding historical tornado events are discussed in the next section (Previous Occurrences and Losses) of this profile.

Figure 5.4.1-9. Tornado Risk in the U.S.

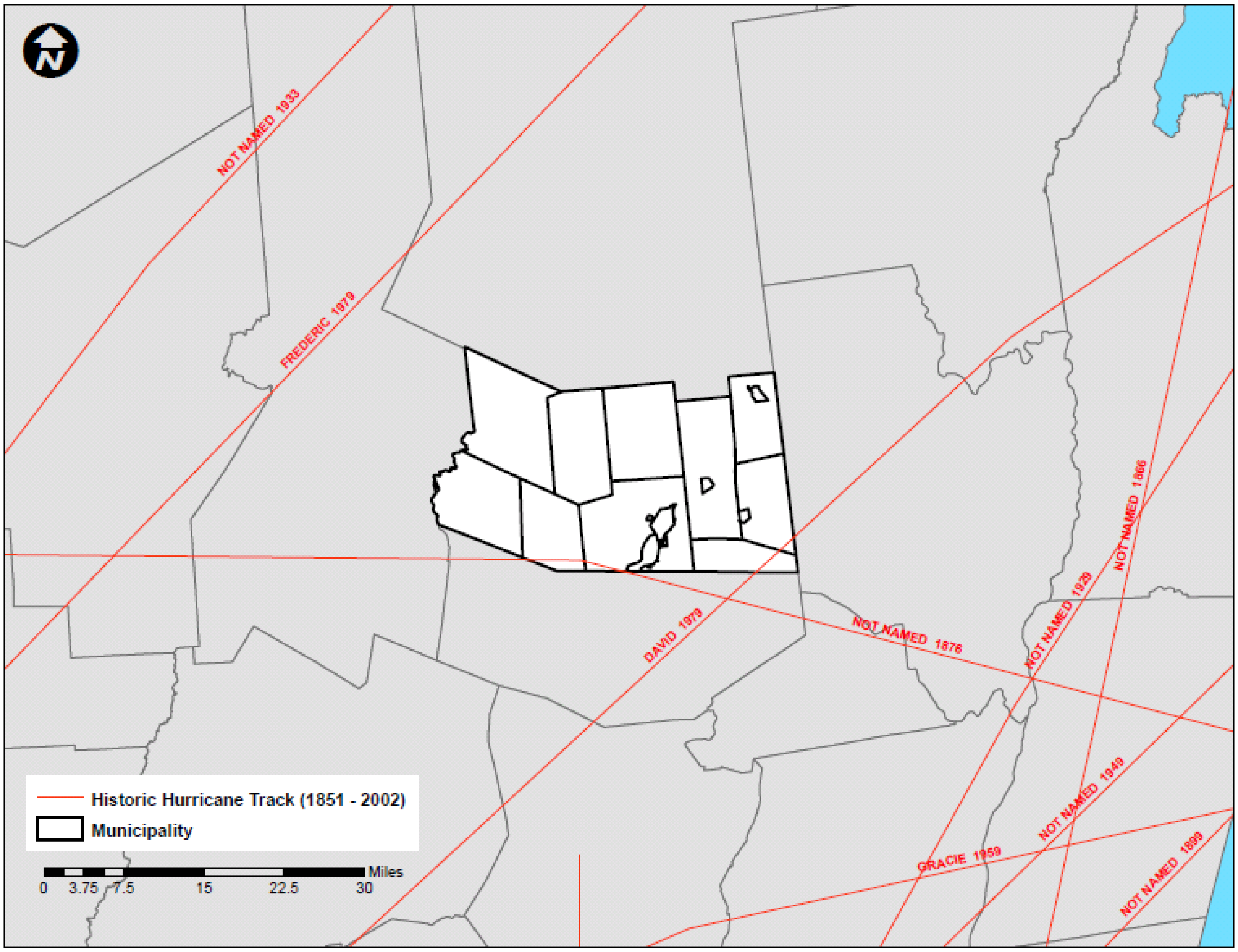


Source: NYSDPC, 2008
Note: Fulton County is shown has having a high risk of tornado occurrences.

Hurricanes / Tropical Storms

Due to Fulton County's inland location, hurricanes do not often make direct landfall on the mitigation study area. However, the County has more frequently been known to experience tropical storms and their indirect landward effects, including high winds, heavy rains, and major flooding associated with hurricane and/or tropical storm events. Hurricanes and tropical storms can impact New York State from June to November, the official eastern U.S. hurricane season. However, late July to early October is the period hurricanes and tropical storms are most likely to impact New York State, due to the coolness of the North Atlantic Ocean waters (NYSDPC, 2008). Figure 5.4.1-10 illustrates the historic hurricane tracks near Fulton County from 1851 to 2002.

Figure 5.4.1-10. Historic North Atlantic Tropical Cyclone Tracks, 1851-2002



Source: NOAA, 2003

From 1903 to 1989, 24 hurricanes and numerous tropical storms have crossed over New York State. The vast majority of these storms have been over the eastern part of the State, specifically in the southeastern corner. This area includes the New York City metropolitan area and the mid and lower Hudson Valley areas. These areas comprise approximately 61-percent of New York State's population (NYSDPC, 2008).

The Historical Hurricane Tracks tool is a public interactive mapping application that displays Atlantic Basin and East-Central Pacific Basin tropical cyclone data. This interactive tool tracks tropical cyclones from 1851 to 2008. Figure 5.4.1-11 displays tropical cyclone tracks for Fulton County; however, some of the associated names for some of these events are unknown. Between 1851 and 2008, Fulton County has experienced 13 tropical cyclone events. These events occurred within 65 nautical miles of the County (NHC, 2006).

Figure 5.4.1-11 Historical North Atlantic Tropical Cyclone Tracks (1851-2008)

Source: NHC, 2009

Note: = Unnamed Tropical Storm/Depression, 1876

+++ = Extra-tropical Storm Frederic, 1979

= Tropical Storm David, 1979

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with severe storms throughout New York State and Fulton County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events could vary. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

Between 1954 and 2009, FEMA declared that New York experienced 43 severe storm-related disasters classified as one or a combination of the following disaster types: severe storms, hurricane (Ida-2009, Ivan-2004, Floyd-1999, Bob-1991, Gloria-1985, Belle-1976, Agnes-1972), coastal storms, flooding, high tides and heavy rain (FEMA, 2010). Of those events, multiple sources, including FEMA, indicated that Fulton County was declared a disaster area as a result of three severe storm events. FEMA couples some disasters as severe storms and flooding events; therefore, those severe storm disasters that are also listed as flooding events have been discussed in Section 5.4.3 (Flood) as well. Table 5.4.1-5 summarizes the FEMA Presidential Disaster (DR) or Emergency Declarations (EM) for severe storm events in Fulton County.

Table 5.4.1-5 Presidential Disaster Declarations for Severe Storm Events in Fulton County

Type of Event*	Date**	Declaration Number	Cost of Losses (approximate)
Severe Storms and Flooding	November 8-15, 1996	DR-1148	New York State experienced approximately $25.6 M in eligible damages. Between November 8 and 9, the storm produced 4 to 5.5 inches of rain across Fulton County. Flash flooding occurred in the Cities of Gloversville and Johnstown. State Highway 10 in the Town of Ephratah was flooded. Several bridges were damaged in the County. According to SHELDUS and NOAA-NCDC, Fulton County had approximately $400 K in property damage.
Severe Storm	September 7, 1998	DR-1244	Multiple New York State Counties suffered extensive damage during this 'Derecho' event. A cluster of fast-moving thunderstorms developed and moved through Rochester and Syracuse, then on into the Mohawk River Valley during the early morning of September 7th. The Derecho continued into southern sections of Vermont and New Hampshire. Fulton, Herkimer, and Montgomery Counties were declared disaster areas. In the City of Gloversville, wind gusts were around 60 mph and toppled a 300 foot radio antenna. The County experienced approximately $1.5 million in damages, which included 350 homes that were destroyed.
Severe Storms and Flooding	June 26 – July 10, 2006	DR-1650	This event was the largest and most costly natural disaster that New York State encountered since Hurricane Agnes in 1972. Resulted in a Disaster Declaration for 19 New York State counties. New York State experienced approximately $246.3 M in eligible damages. As of December 29, 2006, more than $227 M in disaster aid was approved for the State. Between June 28 and 29, in Fulton County, East Canada Creek flooded within the vicinity of the Town of Stratford and the Village of Dolgeville. Route 29A was flooded in the Town of Stratford. Several roads in the Town of Oppenheim were closed due to flooding. Damages for Fulton County were not available.

Source(s): FEMA, 2008; NYSDPC, 2008; Hazards & Vulnerability Research Institute (SHELDUS), 2009; NCDC, 2010; NYSEMO, 2010

Note (1): Dollars rounded to nearest thousand. Recorded losses indicate the dollar value of covered losses paid, as available through the public records reviewed. Some of these events overlap with events shown under the Flood and Severe Winter Storm hazard profiles of this Plan.

* The 'Type of Event' is the disaster classification that was assigned to the event by FEMA.

** Represents the date of the event

Based on all sources researched, many notable severe storm events have impacted Fulton County. All other severe storm events are identified in Table 5.4.1-6 below; however, severe storm documentation for New York is extensive and, therefore, not all sources may have been identified or researched. Hence, Table 5.4.1-6 may not include all events that have occurred throughout the region.

Table 5.4.1-6. Severe Storm Events between 1995 and 2002

Event Name / Date	Location	Losses / Impacts	Source(s)
TSTM / Derecho July 15, 1995 "Adirondack Derecho"	Multi-County	A series of severe thunderstorms crossed the Adirondacks and much of eastern New York State during the morning of July 15th. The storms produced a derecho. The storms also produced tornadoes in eastern New York State and western New England. The wind speeds of these tornadoes reached up to 110 mph. The City of Gloversville of had approximately $100 K in property damage and overall, the County had approximately $500 K in property damage.	NOAA
TSTM / Hail / Tornado May 31, 1998 "Tornado Outbreak"	Multi-County	Several lines of severe TSTMs formed in eastern New York State. The series of storms resulted in six separate tornadoes and storm damage in every county. Widespread power outages occurred throughout eastern New York State. Strong winds downed power lines, power poles and trees. Some counties were declared disaster areas by Governor Pataki. The City of Gloversville had trees and wires down; three houses and two cars were damaged. Wind damage was also reported in different parts of the County. Fulton County had over $80 K in property damage.	NWS, NOAA-NCDC, Hazards & Vulnerability Research Institute (SHELDUS)
Severe Storm September 7, 1998 (FEMA DR-1244)	Multi-County	See FEMA Disaster Declarations (Table 5.4.4-5)	NOAA, NWS, SHELDUS, NOAA-NCDC
Tornado (F1) May 31, 2002	Town of Johnstown	A tornado was confirmed to have touched down in the Town of Johnstown in the early afternoon of May 31st. A wide swath of trees, from about ½ mile southeast of Town eastward for approximately ½ mile across Route 30A east of the Holiday Inn. The Holiday Theater was struck by the tornado, blowing off sections of a roof and the back wall. Trees were uprooted and knocked down behind the theater. The front door was torn off the Holiday Inn and two cars were damaged.	NOAA

Note (1): The intensity of tornado events to affect Fulton County is measured by the Fujita Scale in this Table, which was decommissioned on February 2007. NOAA-NCDC storm query indicated that Fulton County has experienced 219 severe storm events between January 1, 1950 and December 31, 2009 (including Thunderstorms, Hail, Wind, Hurricane, Lightning, and Tornado events). However, not all of these events were identified in this table due to a lack of detail and/or their minor impact upon the County.

Note (2): Monetary figures within this table were U.S. Dollar (USD) figures calculated during or within the approximate time of the event. If such an event would occur in the present day, monetary losses would be considerably higher in USDs as a result of inflation.

* According to many sources, these events were known as Nor'Easters, therefore, they are not discussed further in this hazard profile and are further mentioned in Section 5.4.2 (Severe Winter Storm) and the flooding impact of the events are mentioned in Section 5.4.3 (Flood)

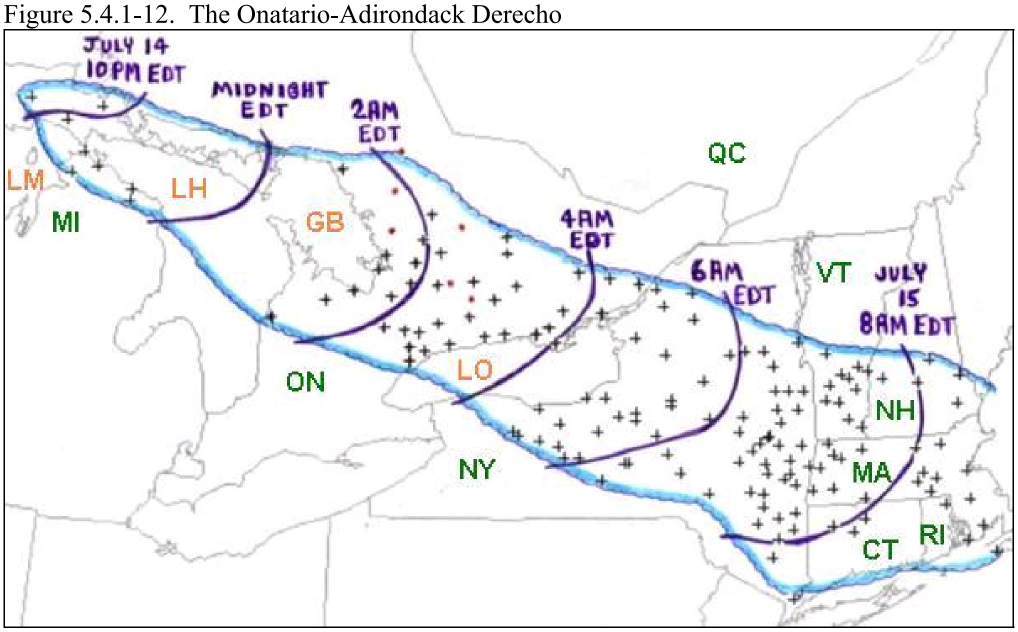
DR	Federal Disaster Declaration
EM	Federal Emergency Declaration
F	Fujita Scale (F0 – F5)
FEMA	Federal Emergency Management Agency
K	Thousand ($)
NCDC	National Climate Data Center
NOAA	National Oceanic Atmospheric Administration
NWS	National Weather Service
NYS DPC	New York State Disaster Preparedness Commission
SHELDUS	Spatial Hazard Events and Losses Database for the U.S.
TSTM	Thunderstorm

Further descriptions of select severe storm events that have impacted Fulton County are provided below with details regarding their impact (where available). These descriptions are provided to give the reader a context of the severe storm events that have affected the County and to assist local officials in locating event-specific data for their municipalities based on the time and proximity of these events. Many severe storm events resulted in major flooding throughout the County; therefore, the flood impacts of these events are further mentioned in Section 5.4.3 (Flood). Also, certain severe storm events have been classified as Nor'Easters; therefore, they are not discussed further in this hazard profile and are further included in Section 5.4.2 (Severe Winter Storm).

Monetary figures within the following event descriptions were U.S. Dollar (USD) figures calculated during or within the approximate time of the event (unless present day recalculations were made by the sources reviewed). If such an event would occur in the present day, monetary losses would be considerably higher in USDs as a result of increased inflation.

July 14-15, 1995 ("The Ontario-Adirondack Derecho"): On the evening of July 14th, thunderstorms producing severe weather were occurring over upper Michigan and adjacent portions of Ontario near Sault Saint Marie. By late evening, the storms developed into a bowing line just northwest of the Mackinac Bridge. The thunderstorm gust front hit the bridge and a gust of 90 mph was measured. Sustained winds above 80 mph continued on the bridge for several minutes, which was the beginning of the "Ontario-Adirondacks Derecho". This system caused hundreds of millions of dollars in damage, several deaths, and many injuries as it moved from the Great Lakes region to the Atlantic coast (SPC, Date Unknown). Figure 5.4.1-12 illustrates the storm path of this system.

Figure 5.4.1-12. The Onatario-Adirondack Derecho



Source: SPC, Date Unknown

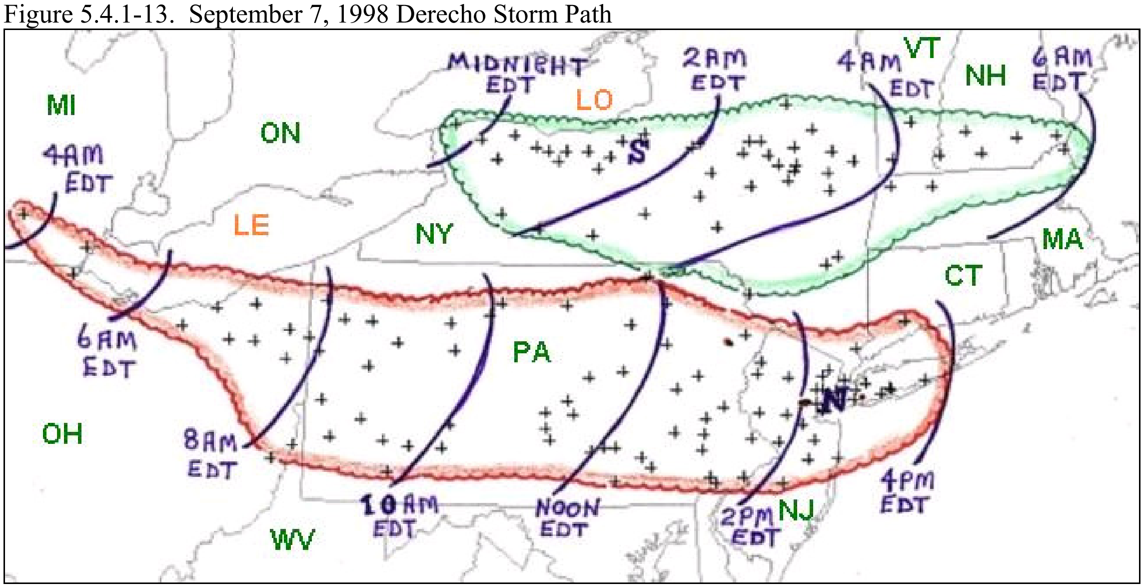
Note: Curved purple lines represent the approximate locations of the "gust front". "+" symbols indicate the locations of wind damage or wind gusts above severe limits (58 mph or greater). Red dots represent tornado occurrences.

In Canada, as the system crossed northern Lake Huron and Georgian Bay, it grew in scale and the derecho winds affected a large area of southern Ontario during the early morning of July 15th. Wind gusts were calculated at 100 mph or more in some locations, causing extensive damage. Several brief tornadoes were associated with this system as well. Most of the tornadoes were weak, but a strong F2 tornado hit the Town of Bridgenorth, destroying a marina and damaging 20 homes. Particularly hard hit was a portion of south central Ontario, with some of the severe damage in the Towns of Huntsville, Bracebridge, Orillia, Minden and Fenelon Falls, all located in Ontario, Canada. Power outages in these areas lasted from several days to a week. According to a report from the Insurance Bureau of Canada, this system resulted in $53 million in 1995 Canadian dollars (SPC, Date Unknown).

As the "Ontario-Adirondacks Derecho" entered New York State on July 15th, severe wind damage continued in this area. Winds were estimated to be 100 mph or greater at several points along a band from Jefferson County and western St. Lawrence County. In the Adirondack Mountain region, over 30 campers and hikers in the area had to be removed by helicopter since their paths out of the forest were blocked by thousands of fallen trees. The NYS DEC estimated about 900,000 acres of forest were damaged with a value loss of timber over $200 million. In the more populated areas of central and eastern New York State, almost $190 million in damage was done to structures and vehicles. Many mobile homes were overturned and numerous homes and businesses were damaged. Several hundred thousands of people were without power due to the powerful derecho winds. Overall, New York State had five deaths, 11 injuries and nearly $400 million in damages (SPC, Date Unknown).

September 7, 1998 (FEMA DR-1244) ("Syracuse Derecho of Labor Day 1998"): A cluster of fast-moving thunderstorms, known as a derecho, developed over western New York State and moved eastward towards the coast of New England resulting in significant wind and hail damage through much of the area. Figure 5.4.1-13 displays the path of the derecho throughout the northeast U.S.

Figure 5.4.1-13. September 7, 1998 Derecho Storm Path



Source: SPC, Date Unknown

Note: The two derecho events are outlined in green and red. The green indicates the Syracuse Derecho and the red indcates the New York City derecho. Curved purple lines represent the approximate locations of the "gust fronts" at two hourly intervals. "+" symbols indicate the locations of wind damage or wind gusts above severe limits (58 mph or greater). Red dots and paths indicate tornado events. A "gust front" is the leading edge of the downdraft (downward moving air) from a thunderstorm.

Probability of Future Events

In Section 5.3, the identified hazards of concern for Fulton County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the County Planning Committee, the probability of occurrence for severe storms in Fulton County is considered "frequent", as presented in Table 5.3-3 in Section 5.3.

It is estimated that Fulton County will continue to experience direct and indirect impacts of severe storms annually that may induce secondary hazards such as flooding, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences.

The Role of Global Climate Change on Future Probability

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts, storms and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution (U.S. Environmental Protection Agency [USEPA], 2009).

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Human-induced climate change has the potential to alter the prevalence and severity of extremes such as heat waves, cold waves, severe storms, floods and droughts. Though predicting changes in these types of events under a changing climate is difficult, understanding vulnerabilities to such changes is a critical part of estimating future climate change impacts on human health, society and the environment (USEPA, 2009).

It is important to understand that directly linking any one specific extreme event (for example, a severe hurricane) to climate change is not possible. However, climate change and global warming may increase the probability of some ordinary weather events reaching extreme levels or of some extreme events becoming more extreme (USEPA, 2009). It remains very difficult to assess the impact of global warming on extreme weather events, in large part because this analysis depends greatly on regional forecasts for global warming. Global warming will almost certainly have different effects on different regions of the Earth, so areas will not be equally susceptible to increased or more intense extreme weather events. Although regional climate forecasts are improving, they are still uncertain (Climate Institute, Date Unknown). These many uncertainties may exist regarding magnitude or severity; however, many sources indicate that future weather patterns and increased intensities are anticipated as a result of climate change, along with atmospheric, precipitation, storm and sea level changes (USEPA, 2009).

VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For severe storms, the entire County has been identified as the hazard area. Therefore, all assets in Fulton County (population, structures, critical facilities and lifelines), as described in the County Profile section (Section 4), are vulnerable. The following text evaluates and estimates the potential impact of severe storms on the County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact, including: (1) impact on life, safety and health of County residents, (2) general building stock, (3) critical facilities, (4) economy and (5) future growth and development
- Further data collections that will assist understanding of this hazard over time
- Overall vulnerability conclusion

Overview of Vulnerability

Severe storms include high winds and air speeds that result in power outages, disruptions to transportation corridors and equipment, loss of workplace access, significant property damage, injuries and loss of life, and the need to shelter and care for individuals impacted by the events. A large amount of damage can be inflicted by trees, branches, and other objects that fall onto power lines, buildings, roads, vehicles, and, in some cases, people. The risk assessment for severe storm evaluates available data for a range of storms included in this hazard category.

Due to the County's inland location, the loss associated with hurricanes is primarily associated with severe thunderstorm or tropical storm/hurricane-related severe winds and rain (see flooding discussion in Section 5.4.3 Flood). Secondary flooding associated with the torrential downpours during severe storms is also a primary concern in the County. The County has experienced flooding in association with numerous severe storms in the past.

In the study area, winds associated with a tropical/hurricane storm event are similar to a severe wind storm and therefore, can support analysis of the severe storm event for this study area. The entire inventory of the County is at risk of being damaged or lost due to impacts of severe wind. Certain areas, infrastructure, and types of building are at greater risk than others due to proximity to falling hazards and/or their manner of construction.

Potential losses associated with high wind events were calculated for the County for two probabilistic wind events, the 100-year and 500-year mean return period (MRP) wind events. The impacts on population, existing structures and critical facilities are presented below, following a summary of the data and methodology used.

Data and Methodology

After reviewing historic data, the HAZUS-MH methodology and model were used to analyze the wind (severe storm) hazard for Fulton County. Data used to assess this hazard include data available in the HAZUS-MH MR4 hurricane model, NOAA NCDC data, professional knowledge, and information provided by the Planning Committee.

A probabilistic scenario was run for Fulton County for annualized losses and the 100- and 500-year MRPs were examined for the wind/severe storm hazard. Figures 5.4.1-1 and 5.4.1-2, earlier in this section, show the HAZUS-MH MR4 maximum peak gust wind speeds that can be anticipated in the study area associated with the 100- and 500-year MRP hurricane events. The estimated hurricane track for the 100- and 500-year events is also shown.

HAZUS-MH contains data on historic hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Hurricane and inventory data available in HAZUS-MH were used to evaluate potential losses from the 100- and 500-year MRP events (severe wind impacts). Locally available inventory data were reviewed to determine their appropriateness for inclusion. Other than data for critical facilities, the default data in HAZUS-MH MR4 was the best available for use in this evaluation. The 11 residential and 10 commercial occupancy classes available in HAZUS-MH were condensed into the following occupancy classes (residential, commercial, industrial, agricultural, religious, government, and educational) to facilitate the analysis and the presentation of results. Residential loss estimates address both multi-family and single family dwellings. In addition, impacts to critical facilities were evaluated for the 100-year and 500-year MRP events.

Impact on Life, Health and Safety

The impact of severe storms on life, health and safety is dependent upon the severity of the storm event. Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. It is assumed that the entire County population is exposed to the severe storm hazard. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 5.4.1-7 summarizes the population over the age of 65 and individuals living below the Census poverty threshold. Additionally, residents living in mobile homes are particularly vulnerable to wind events due to the construction of their housing. The Impact on General Building Stock subsection below discusses mobile homes in the County further.

Table 5.4.1-7. Vulnerable Population Exposed to the Severe Storm Hazard in Fulton County

Population Category	Number of Persons Exposed**	Percent of Total Population**
Elderly (Over 65 years of age) (1)	9,729	17.0
Persons living below Census poverty threshold* (2)	6,235	10.9
Elderly (Over 65 years of age) living below Census poverty threshold (2)***	638	1.2
Population Category	**Number of Persons Exposed**	**Percent of Total County Population**
Elderly (Over 65 years of age) (1)	8,900	16.2
Persons living below Census poverty threshold* (2)	6,686	12.1
Elderly (Over 65 years of age) living below Census poverty threshold (2)	638	1.2

Source(s): (1) HAZUS-MH MR4; U.S. Census 2000.
* The Census poverty threshold for a three person family unit is approximately $15,000.
** These values represent Fulton County and the entire Village of Dolgeville.
*** This value only represents the population within the Fulton County boundary and does not include the portion of the Village of Dolgeville located in Herkimer County.

For a 100-year and 500-year MRP events, HAZUS-MH MR4 estimates that no households will be displaced and zero households will require temporary shelter. For the 100-year event, HAZUS-MH MR4 estimates no debris will be generated. For a 500-year MRP event, HAZUS-MH MR4 estimates 225 tons of brick and wood debris and a total of 27,277 tons of tree debris will be generated. Table 5.4.1-8 estimates the debris produced for the 500-year MRP event per municipality.

Please note that the HAZUS-MH Hurricane Model Technical Manual and User Manual recommend that the estimated debris volume be treated as a low estimate. There may be other sources of vegetative and non-vegetative debris (i.e., flooding) not being modeled in HAZUS-MH in combination with the wind. Therefore, this is likely a conservative estimate and may be higher if multiple impacts occur.

Table 5.4.1-8. Debris Production for 500-Year MRP Event Winds

Municipality	Brick and Wood (tons)	Concrete (tons)	Tree (tons)
Bleecker (T)	0	0	0
Broadalbin (T)	8	0	1,969
Broadalbin (V)	4	0	62
Caroga (T)	1	0	0
Dolgeville (V)*	6	0	27
Ephratah (T)	0	0	3,757
Gloversville (C)	115	0	22
Johnstown (C)	70	0	54
Johnstown (T)	0	0	4,483
Mayfield (T)	9	0	1,313
Mayfield (V)	0	0	6
Northampton (T)	3	0	1,270
Northville (V)	2	0	62
Oppenheim (T)	0	0	5,377
Perth (T)	7	0	1,665
Stratford (T)	0	0	7,210
Fulton County	**225**	**0**	**27,277**

Source: HAZUS-MH MR4
Note: *These values represent the entire Village of Dolgeville (both portions in Fulton and Herkimer Counties).

Impact on General Building Stock

After considering the population exposed to the severe storm hazard, the value of general building stock exposed to and damaged by 100- and 500-year MRP events was evaluated. Potential damage is the modeled loss that could occur to the exposed inventory. HAZUS-MH MR4 estimates there is a total building replacement value (structure only) of greater than $4 billion in Fulton County. Greater than 75-percent of the building stock value is associated with residential housing. The analysis below uses the replacement value (building structure and does not include building contents) with the valuation of general building stock and the loss estimates determined in Fulton County based on the default general building stock database provided in HAZUS-MH MR4. The general building stock valuations provided in HAZUS-MH MR4 are Replacement Cost Value from RSMeans as of 2006.

Table 5.4.1-9 presents the total exposure value for general building stock by occupancy class for the County.

Table 5.4.1-9. Building Stock Replacement Value (Structure Only) by Occupancy Class

Municipality	Total Replacement Value	Residential Replacement Value	Commercial Replacement Value	Industrial Replacement Value
Bleecker (T)	$56,230,000	$53,315,000	$2,010,000	$508,000
Broadalbin (T)	$256,461,000	$226,108,000	$14,830,000	$3,500,000
Broadalbin (V)	$90,402,000	$58,644,000	$14,958,000	$5,649,000
Caroga (T)	$234,377,000	$219,551,000	$8,990,000	$1,273,000
Dolgeville (V)	$149,722,000	$108,123,000	$22,202,000	$10,818,000
Ephratah (T)	$78,484,000	$72,610,000	$3,946,000	$1,738,000
Gloversville (C)	$1,105,210,000	$807,907,000	$174,348,000	$81,231,000
Johnstown (C)	$776,521,000	$471,419,000	$174,731,000	$86,356,000
Johnstown (T)	$479,387,000	$361,025,000	$60,335,000	$19,783,000
Mayfield (T)	$353,165,000	$295,984,000	$40,031,000	$8,052,000
Mayfield (V)	$57,057,000	$43,949,000	$5,349,000	$1,163,000
Northampton (T)	$168,935,000	$157,963,000	$8,998,000	$1,053,000
Northville (V)	$92,066,000	$74,175,000	$11,183,000	$1,202,000
Oppenheim (T)	$87,130,000	$65,088,000	$7,338,000	$10,003,000
Perth (T)	$206,155,000	$176,770,000	$19,140,000	$8,210,000
Stratford (T)	$51,148,000	$47,348,000	$1,570,000	$122,000
Fulton County	**$4,242,450,000**	**$3,239,979,000**	**$569,959,000**	**$240,661,000**

Source: HAZUS-MH MR4

Notes:

(1) Replacement value reflects the building structure and does not include building contents. The valuation of general building stock and the loss estimates determined in Fulton County were based on the default general building stock database provided in HAZUS-MH MR4. The general building stock valuations provided in HAZUS-MH MR4 are Replacement Cost Value from RSMeans as of 2006.

(2) Total RV is the sum of all building classes (Residential, Commercial, Industrial, Agricultural, Religious, Government and Education).

(3) The total RV for the agricultural occupancy class is $10,979,000; the total RV for the religious occupancy class is $68,539,000; the total RV for the government occupancy class is $52,742,000; and the total RV for the education occupancy class is $59,591,000.

(4) The building stock replacement value represents the entire Village of Dolgeville (portions in both Fulton and Herkimer Counties).

The HAZUS-MH hurricane analysis considers damage associated with significant winds. Such wind impacts also could occur as a result of the severe wind storms or tornadoes and therefore, are considered relevant to the severe storm hazard. Rain often is associated with severe storms and heavy rains could result in flooding. Flooding is addressed under the flood hazard (Section 5.4.3).

The entire study area is considered at risk for the severe storm wind hazard. Expected building damage was evaluated by HAZUS-MH across the following damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table 5.4.1-10 summarizes the definition of the damage categories.

Table 5.4.1-10. Description of Damage Categories

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
1. No Damage or Very Minor Damage Little or no visible damage from the outside. No broken windows, or failed roof deck. Minimal loss of roof over, with no or very Limited water penetration.	≤2%	No	No	No	No	No
2. Minor Damage Maximum of one broken window, door or garage door. Moderate roof cover loss that can be Covered to prevent additional water Entering the building. Marks or dents on walls requiring painting or patching for repair.	>2% and ≤15%	One window, door, or garage door failure	No	<5 impacts	No	No
3. Moderate Damage Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water.	>15% and ≤50%	> one and ≤ the larger of 20% & 3	1 to 3 panels	Typically 5 to 10 impacts	No	No
4. Severe Damage Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	>50%	> the larger of 20% & 3 and ≤50%	>3 and ≤25%	Typically 10 to 20 impacts	No	No
5. Destruction Complete roof failure and/or, failure of wall frame. Loss of more than 50% of roof sheathing.	Typically >50%	>50%	>25%	Typically >20 impacts	Yes	Yes

Source: HAZUS-MH Hurricane Technical Manual

As noted earlier in this profile, wind speeds associated with the 100-year MRP event are less than 50 mph, characteristic of a tropical cyclone or tropical storm. Peak gust wind speeds for the 500-year MRP range from 67 to 71 mph; wind speeds characteristic of a tropical storm and nearly a Category 1 hurricane. Because the estimated wind risk is low, there are mainly minor structural damages estimated.

In summary, HAZUS-MH MR4 does not estimate any structural damage as a result of the 100-year MRP event. HAZUS-MH MR4 only estimates minor building damage to the residential occupancy class as a result of the 500-year event. Because of differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Mobile homes are particularly vulnerable to severe storms and wind damage. According to HAZUS-MH MR4, there are a total of 3,126 mobile homes in the study area with a structural replacement value of approximately

$37,000 each. Of the nearly $2.5 million in structural damage estimated as a result of the 500-year event, approximately $120,561 is estimated damage to manufactured homes (mobile homes) in Fulton County.

Table 5.4.1-11 summarizes the general building stock damage estimated by HAZUS-MH MR4 for the 100- and 500-year MRP hurricane events for the County as a whole. Table 5.4.1-12 summarizes the general building stock damage estimated for the 100- and 500-year MRP hurricane events for each participating municipality. The data shown in both tables indicate total losses associated with wind damage to building structure only. The damage estimates include buildings damaged at all severity levels from minor damage to total destruction and the total dollar damage reflects the overall impact to buildings at an aggregate level. In addition, the annualized losses were examined for Fulton County; see Table 5.4.1-13. Please note that annualized loss does not predict what losses will occur in any particular year.

Table 5.4.1-11. Estimated Fulton County Building Replacement Value (Structure Only) Damaged by the 100-Year and 500-Year MRP Winds

Occupancy Category	Building Value Damage (Structure Only)	
	100-Year	500-Year
Residential	$0	$2,287,762
Commercial	$0	$56,996
Industrial	$0	$24,066
Agricultural, Religious Government , Education	$0	$24,941

Source: HAZUS-MH MR4

Note: These totals include Fulton County and the entire Village of Dolgeville.

Table 5.4.1-12. Estimated Building Value (Structure Only) Damaged by the 100-Year and 500-Year MRP Winds

Municipality	Total (All Occupancy Classes)		Percentage of Total Building Value		Residential Buildings		Commercial Buildings		Industrial Buildings	
	100 Yr	500 Yr	100 Yr	500 Yr	100 Yr	500 Yr	100 Yr	500 Yr	100 Yr	500 Yr
Bleecker (T)	$0	$32,793	0	0.1	$0	$32,501	$0	$201	$0	$51
Broadalbin (T)	$0	$161,007	0	0.1	$0	$157,972	$0	$1,483	$0	$350
Broadalbin (V)	$0	$40,379	0	0.0	$0	$37,203	$0	$1,496	$0	$565
Caroga (T)	$0	$130,892	0	0.1	$0	$129,431	$0	$899	$0	$127
Dolgeville (V)(3)	$0	$73,082	0	0.0	$0	$68,922	$0	$2,220	$0	$1,082
Ephratah (T)	$0	$51,763	0	0.1	$0	$51,194	$0	$395	$0	$174
Gloversville (C)	$0	$561,542	0	0.1	$0	$531,812	$0	$17,435	$0	$8,123
Johnstown (C)	$0	$411,809	0	0.1	$0	$381,299	$0	$17,473	$0	$8,636
Johnstown (T)	$0	$309,665	0	0.1	$0	$298,035	$0	$6,034	$0	$1,978
Mayfield (T)	$0	$223,123	0	0.1	$0	$217,506	$0	$4,003	$0	$805
Mayfield (V)	$0	$26,211	0	0.0	$0	$24,912	$0	$535	$0	$116
Northampton (T)	$0	$109,185	0	0.1	$0	$108,088	$0	$900	$0	$105
Northville (V)	$0	$50,115	0	0.1	$0	$48,326	$0	$1,118	$0	$120
Oppenheim (T)	$0	$47,425	0	0.1	$0	$45,321	$0	$734	$0	$1,000
Perth (T)	$0	$125,317	0	0.1	$0	$122,379	$0	$1,914	$0	$821
Stratford (T)	$0	$33,222	0	0.1	$0	$32,860	$0	$157	$0	$12
Fulton County	**$0**	**$2,387,530**	**0**	**0.1**	**$0**	**$2,287,762**	**$0**	**$56,996**	**$0**	**$24,066**

Source: HAZUS-MH MR4

Notes:

(1) Values represent replacement values (RV) for building structure only (does not include contents).

(2) The valuation of general building stock and the loss estimates determined in Fulton County were based on the default general building stock database provided in HAZUS-MH MR4. The general building stock valuations provided in HAZUS-MH MR4 are Replacement Cost Value from RSMeans as of 2006.

(3) These values represent the entire Village of Dolgeville.

Table 5.4.1-13. Summary of Estimated Annualized Wind General Building Stock Losses for Fulton County

Municipality	Total (Buildings + Contents)	Buildings	Contents
Bleecker (T)	$341	$297	$22
Broadalbin (T)	$2,699	$2,356	$146
Broadalbin (V)	$783	$633	$54
Caroga (T)	$1,381	$1,197	$89
Dolgeville (V)(2)	$650	$520	$60
Ephratah (T)	$410	$347	$31
Gloversville (C)	$9,559	$7,349	$1,025
Johnstown (C)	$6,608	$4,951	$824
Johnstown (T)	$3,750	$3,037	$381
Mayfield (T)	$3,117	$2,668	$207
Mayfield (V)	$364	$309	$22
Northampton (T)	$1,699	$1,467	$109
Northville (V)	$828	$699	$59
Oppenheim (T)	$417	$336	$40
Perth (T)	$2,045	$1,752	$130
Stratford (T)	$266	$223	$20
Fulton County	**$34,917**	**$28,141**	**$3,217**

Source: HAZUS-MH MR4
Notes:
(1) The valuation of general building stock and the loss estimates determined in Fulton County were based on the default general building stock database provided in HAZUS-MH MR4. The general building stock valuations provided in HAZUS-MH MR4 are Replacement Cost Value from RSMeans as of 2006.
(2) These values represent the entire Village of Dolgeville.

Residential buildings account for a majority of the building stock damage and also comprise the majority of the building inventory. Because of differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Figure 5.4.1-14 shows the density of damage estimated for residential structures for the 500-year MRP event. As anticipated, HAZUS estimates the most damage within the populated and built environments in the County.

Based on historical events and damages to Fulton County, HAZUS appears to be underestimating the damages the County and its municipalities incur as a result of severe storm events.

Impact on Critical Facilities

100-Year MRP Event – HAZUS-MH estimates the hospital, police departments, fire stations and schools will not suffer damage during a 100-year event. All facilities are estimated to be fully functional (no loss of use). HAZUS-MH MR4 does not estimate damages to utilities or transportation features.

500-Year MRP Event – HAZUS-MH estimates the hospital, police departments, fire stations and schools have less than one-percent chance of suffering minor damage during a 500-year event. All facilities are estimated to be fully functional (no loss of use). HAZUS-MH MR4 does not estimate damages to utilities or transportation features.

Impact on Economy

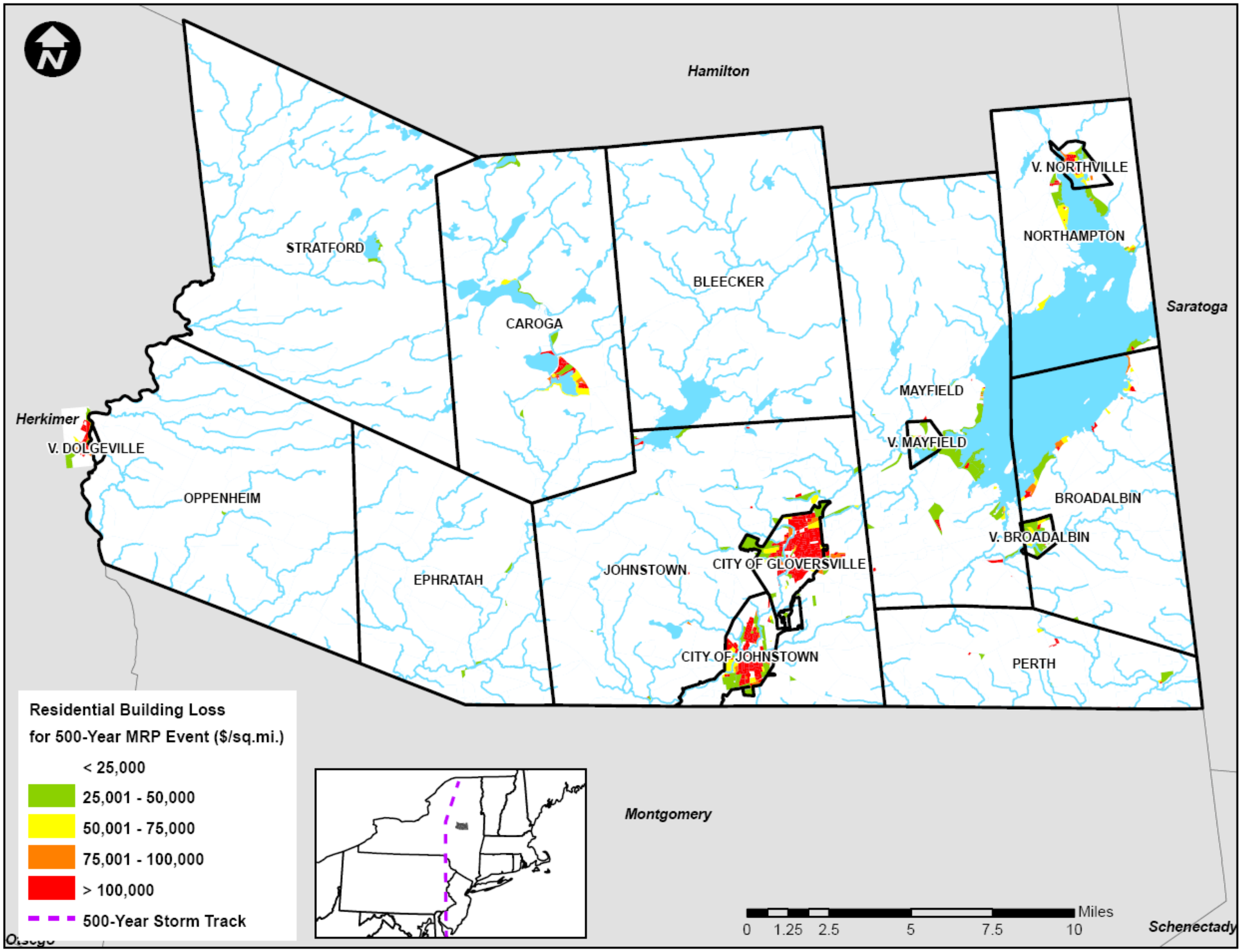
Severe storms also have impacts on the economy, including: loss of business function, damage to inventory, relocation costs, wage loss and rental loss due to the repair/replacement of buildings. HAZUS-MH estimates the total economic loss associated with each storm scenario (direct building losses and business interruption losses). Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is reported in the Impact on General Building Stock sub-section discussed earlier ($2,387,530). Business interruption losses are the losses associated with the inability to operate a business because of the damage sustained during the storm.

HAZUS-MH MR4 does not estimate that any commercial or industrial business interruption loss will occur for the 100-year MRP event. For the 500-year MRP event, HAZUS-MH estimates a loss of approximately $24,380 for the study area as a whole; associated with relocation and rental costs for residential and commercial occupancy classes. Therefore, the total building related economic losses to Fulton County is estimated at nearly $2.5 million ($2,387,530 in direct building losses and $24,380 in business interruption losses).

Transportation lifelines are not considered particularly vulnerable to the 100- and 500-year MRP severe storm wind hazard. However, utility structures could suffer damage associated with falling tree limbs or other debris. Such impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to citizens (including the young and elderly, who are particularly vulnerable to temperature-related health impacts).

It is estimated that the impact to the economy, as a result of a severe storm event, would be considered "low" in accordance with the risk ranking shown in Section 5.3.

Figure 5.4.1-14. Density of Losses for Residential Structures (Structure Only) for the 500-Year MRP Wind Event



Source: HAZUS-MH MR4

Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the severe storm hazard because the entire planning area is exposed and vulnerable. For the severe storm hazard, the entire County has been identified as the hazard area. Please refer to Section 4 (County Profile) and each municipalities' annex (Section 9) for maps that illustrate where potential new development is located in relation to Fulton County's hazard areas.

Additional Data and Next Steps

Over time, Fulton County will obtain additional data to support the analysis of this hazard. Data that will support the analysis would include additional detail on past hazard events and impacts, additional information on estimated frequency of these events, and future data regarding events and damages as they occur. In addition, information on particular buildings or infrastructure and their value will support updates regarding the particular assets in the County that are most vulnerable to severe storm (wind-related) events. Additional utility data would support an improved assessment of potential damage for this infrastructure category.

For the severe storm events that cannot currently be directly modeled in HAZUS-MH (tornado, thunderstorm, etc.), additional detailed loss data from past and future events will assist in assessing potential future losses. Based on these values and a sufficient number of data points, future losses could be modeled. Alternately, percent of damage estimates could be made and multiplied by the inventory value to estimate potential losses. This methodology is based on FEMA's How To Series (FEMA 386-2), Understanding Your Risks, Identifying and Estimating Losses (FEMA, 2001) and FEMA's Using HAZUS-MH for Risk Assessment (FEMA 433) (FEMA, 2004). Finally, with time, HAZUS-MH will be released with modules that address hurricane wind and associated flooding as one model and will include a tornado module. As this version of HAZUS-MH is released, the County can run analyses for the tornado hazard and re-run an analysis for an overall picture of the hurricane-associated wind and flood damages.

Overall Vulnerability Assessment

Severe storms are common in the study area, often causing impacts and losses to the structures, facilities, utilities, and population in Fulton County. Existing and future mitigation efforts should continue to be developed and employed that will enable the study area to be prepared for these events when they occur. The overall hazard ranking determined by the Planning Committee for this hazard is "high" with a "frequent" probability of occurrence (see Tables 5.3-3 through 5.3-6 in Section 5.3).